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AF/1722/$

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:

Janis Virbulis et al.

Serial No.: 10/053,446

Filed: January 17, 2002

Group Art Unit: 1722

Examiner: Matthew J. Song

For: PROCESS AND APPARATUS FOR PRODUCING A SILICON SINGLE CRYSTAL

Attorney Docket No.: WSAG 0128 PUS

APPEAL BRIEF UNDER 37 C.F.R. § 41.37

Mail Stop Appeal Brief - Patents
Commissioner for Patents
U.S. Patent & Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Applicant hereby petitions for a one-month extension of time to file a Brief in Support of the Notice of Appeal mailed July 5, 2005, thereby extending the time period within which to respond to October 7, 2005.

This is an Appeal Brief from the final rejection of claims 1, 2, 14, 17 and 18 of the Office Action mailed on April 4, 2005 for the above-identified patent application.

CERTIFICATE OF MAILING UNDER 37 C.F.R. § 1.8

I hereby certify that this paper, including all enclosures referred to herein, is being deposited with the United States Postal Service as first-class mail, postage pre-paid, in an envelope addressed to: Mail Stop Appeal Brief - Patents, Commissioner for Patents, U.S. Patent & Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450 on:

October 7, 2005	James W. Proscia	[signature]
Date of Deposit	**Name of Person Signing**	**Signature**

I. REAL PARTY IN INTEREST

The real party in interest is Siltronic A.G., ("Assignee"), a corporation of Germany, by virtue of Assignment from the inventors to Wacker Siltronic Gesellschaft für Halbleitermaterialen, A.G., as set forth in the assignment recorded in the U.S. Patent and Trademark Office on March 15, 2002 at Reel 012724/Frame 0148, and then to, by change of name, Siltronic A.G., recorded at Reel/Frame 015596/0720.

II. RELATED APPEALS AND INTERFERENCES

There are no appeals or interferences known to the Appellant, the Appellant's legal representative, or the Assignee which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

III. STATUS OF CLAIMS

Claims 1, 2, 14, 17 and 18 are pending in this application. Claims 1, 2, 14, 17 and 18 have been rejected and are the subject of this appeal.

IV. STATUS OF AMENDMENTS

A Response after Final Rejection was filed on July 5, 2005 without an accompanying amendment.

V. SUMMARY OF CLAIMED SUBJECT MATTER

The present invention provides a process for producing single crystal silicon. In one embodiment, the process of the invention comprises pulling a silicon single crystal from a silicon melt which is contained in a crucible. (Specification, p. 2, ll. 17-20). The crucible is characterized in having a crucible wall and a diameter of at least 450 mm. (Specification, p. 3, ll. 5-12). A heat shield is placed above the crucible. (Specification, p. 3, ll. 5-12).

Subsequently, the silicon single crystal is pulled with a diameter of at least 200 mm. (Specification, p. 5, ll. 11-16). The silicon melt is exposed to a magnetic field consisting of a traveling magnetic field which exerts a substantially vertically oriented force on the melt in a region of the crucible wall. (Specification, p. 3, ll. 1-4.) In one variation, the magnetic field consists of a traveling magnetic field which exerts a substantially vertically downwardly oriented force on the melt in a region of the crucible wall. (Specification, p. 4, l. 19 - p. 5, l. 2). In another variation, the magnetic field consists of a traveling magnetic field which exerts a substantially vertically upwardly oriented force on the melt in a region of the crucible wall. (Specification, p. 6, ll.8-12). The magnetic field is applied with an intensity which is sufficient to attenuate low-frequency temperature fluctuations in the melt. (Specification, p. 11, ll. 3-6). In a variation of the invention, the magnetic field is generated with three coils that are connected to a 3-phase power supply, with a phase angle in an order 0°-60°-120° or 0°-120°-240°. (Specification, p. 9, l. 19 - p.10, l. 4).

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claims 1-2 and 17-18 are rejected under 35 U.S.C. §103(a) as being unpatentable over Tamatsuka et al. (U.S. Patent No. 6,139,625) in view of Luter et al.

Claim 14 is rejected under 35 U.S.C. 103(a) as being unpatentable over Tamatsuka et al. (U.S. Patent No. 6,139,625) in view of Luter et al. (U.S. Patent No. 6,053,974) along with Aratani (DE 3701811), as applied to claims 1-2 and 17-18 above, and further in view of Lari et al. (U.S. Patent No. 4,905,756) or Morishita et al. (JP 61-029128).

VII. ARGUMENT

A. Claims 1-10 Are Patentable Under 35 U.S.C. § 103(a) Over U.S. Patent Nos. 6,139,625 and 6,053,974 and German Patent No. DE 3701811

Claims 1-2 and 17-18 are rejected under 35 U.S.C. §103(a) as being unpatentable over Tamatsuka et al. (U.S. Patent No. 6,139,625) in view of Luter et al. (U.S. Patent No. 6,053,974) along with Aratani (DE 3701811).

Applicants respectfully traverse this rejection for the reasons set forth below and in previous responses. The Examiner has inappropriately used hindsight to reconstruct the present invention as disclosed in claims 1-2 and 17-18 in a piecemeal approach from the Tamatsuka et al., Luter et al. and the Aratani references. First, the Examiner uses Luter et al. to provide the heat shield which is missing in Tamatsuka et al. Next, the Examiner uses Aratani to provide the traveling magnetic field missing from both Tamatsuka et al. and Luter et al. Moreover, the Examiner completely neglects the fact that the Aratani reference teaches away from the present invention thereby making its combination with Tamatsuka et al. and/or Luter completely inappropriate. At issue in the Examiner's combining of references is an attempt to produce the combination of a heat shield and a traveling magnetic field in a process for producing a single silicon crystal. None of the references standing alone provide such a process.

The Examiner concedes that the "combination of Tamatsuka et al. and Luter et al. is silent to exposing the silicon melt to an influence of a traveling magnetic filed which exerts a substantially vertically orientated force on the melt in a region of the crucible wall." (Office Action dated April 4, 2005). The Examiner relies on Aratani to provide this missing element in reconstructing the present invention. Specifically, the Examiner states that:

> In a method of producing a single crystal using the Czochralski method, Aratani teaches applying a downwardly traveling magnetic field to the melt in the crucible, this reads on applicants' vertically oriented force. Aratani also discloses a single magnetic field application device 8, note Figure 1, this reads on applicants' except for the traveling magnetic field no further magnetic field being applied to the melt.
>
> Office Action dated April 4, 2005

Moreover, the Examiner incorrectly attempts to justify the combining of Aratani with Tamatsuka et al. and Luter et al. by stating:

> Traveling magnetic field are known in the art to be **advantageous in minimizing dissolution of oxygen from the silica material of a crucible and for stirring a melt in Czochralski processes**, as evidenced by Aratani (DE 3701733) and Szekely et al (US 5,196,085) below. Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Tamatsuka et al and Luter et al by applying a traveling magnetic field, as taught by Aratani to minimize dissolution of oxygen from the silica of the crucible and for stirring the melt, which is desirable.
>
> Office Action dated April 4, 2005 (emphasis added)

It is worth noting at this point that in the Advisory Action, the Examiner plays a short of hidden ball game in his utilization of the Aratani references. The Examiner states that:

> Applicant's arguments stating the differences between Aratani and the present invention are noted but are not found persuasive. Applicant compares Aratani (DE 3701733 A l), note page 3 of the response. However, the Examiner uses Aratani (DE 3701811 A1) for the basis of the rejection, The arguments arc not persuasive because applicant's arguments are not directed to the applied prior art. Aratani (3701811 A1) does not mention oxygen inclusion. "811 merely desires constant resistivity.

Advisory Action dated July 20, 2005

Applicants will allow the Examiner's use of the DE3701733 reference reproduced above to speak for itself. Regardless, the Examiner's conclusory statement in the Advisory Action adds nothing to the inappropriateness of the combining of Aratani (3701811) with Tamatsuka and Luter. Aratani (3701811) does not disclose the use of a heat shield. Moreover, Aratani does not disclose adjusting oxygen level through the action of a traveling magnet field as disclosed in the present application and described below.

None of the references cited by the Examiner disclose a process in which oxygen dissolution is not minimized but raised as in the first embodiment . (Specification, p. 3, ll. 13-16.) Again, it should be appreciated that the ability to adjust the oxygen upward if desired is manifested in the claims by the heat shield and traveling magnetic field limitations. In opposite to the statements of the Examiner in the April 4, 2005 Office Action, the Specification clearly states:

> Surprisingly, the effect of the **oxygen levels being reduced**, which is described in DE-37 01733 A1, **does not occur** when the invention is carried out in accordance with a **first embodiment**. It is assumed that the reason for this is that, when a single crystal is being pulled in accordance with DE-37 01 733 A1, the **upwardly directed thermal convection** is decelerated by applying a **traveling magnetic field with the force directed downward**. Consequently, the flow velocity which is responsible for the oxygen transport and the inclusion of oxygen in the silicon single crystal is slowed by the influence of the magnetic field. Therefore a larger quantity of oxygen can escape via the surface of the melt in the form of SiO, and accordingly less oxygen is included in the single crystal.
>
> Specification, paragraph 10 (emphasis added)

The ability to adjust the oxygen level upwards in the present invention can be attributed to differences in the convective flows. Specifically, the Specification explains this difference from Aratani by stating:

> By contrast, in the present invention it is not the rate of flow, but rather it is the **direction of flow**, which plays the decisive role. When pulling a silicon single crystal with a diameter of at least 200 mm out of a crucible with a diameter of at least 450 mm, with a traveling magnetic field applied with its force directed downward (first embodiment of the invention), the direction of flow is no longer directed upward, toward the surface of the melt. Rather, **convection is established, which is initially directed toward the base of the crucible and later toward the growing single crystal**. As a result, oxygen is included in the growing silicon single crystal at a virtually constant rate. This occurs even though a crucible promotes the evaporation of SiO out of the melt, since it allows a relatively large open surface of the melt to be used.
>
> Specification, paragraph 11 (emphasis added)

The Specification explains the differences between the Aratani references (must be both Aratani references since neither discloses using a heat shield) and the present invention are the result of differences in the direction of convective flow which is of course is on average from a hot to cooler location. Of course, this difference between the flow directions (i.e., convection) must be present in independent claims 1, 17, and 18 if these claims are to be patentable. Indeed, this difference is at least in part manifested in these claims by the inclusion of a heat shield. The Specification explains that the heat shield "promotes the evaporation of SiO out of the melt, it does this by **increasing the temperature of the melt surface**." Clearly, the inclusion of the heat shield increases the surface temperature of the melt which inevitably affects the convective flows in the melt. Since the first embodiment of the invention does not lead to a decrease in oxygen levels as desired by Aratani, Aratani teaches away from the inclusion of a heat shield when a downwardly directed magnetic force is used. Accordingly, the combination of Aratani with Tamatsuka et al. and Luter et al. is incompatible.

The Examiner's statement in the July 20, 2005 Advisory Action that applicant's arguments that the references fail to show certain features of the invention is unenlightened. At least one manifestation of these differences occurs in the claims as the simultaneous requirement of a heat shield and a traveling magnetic field.

For the reasons set forth above, claims 1-2 and 17-18 are allowable over the combination of Tamatsuka et al., Luter et al., and Aratani.

B. Claim 14 Is Patentable Under 35 U.S.C. § 103(a) Over U.S. Patent Nos. 6,139,625 and 6,053,974, German Patent No. DE 3701811, and Japanese Patent No. JP 61-029128

Claim 14 is rejected under 35 U.S.C. 103(a) as being unpatentable over Tamatsuka et al. (U.S. Patent No. 6,139,625) in view of Luter et al. (U.S. Patent No. 6,053,974) along with Aratani (DE 3701811), as applied to claims 1-2 and 17-18 above, and further in view of Lari et al.(U.S. Patent No. 4,905,756) or Morishita et al. (JP 61-029128)

Claim 14 is patentable over the combination of Tamatsuka et al., Luter et al., Aratani and for the same reasons as set forth above. Similarly, neither Lari et al. nor Morishita et al. disclose the utilization of a heat shield nor the motivation to combine such a heat shield with a traveling magnet field in a process for producing a silicon single crystal. It must also be appreciated that utilization of both Lari et al. and Morishita et al. is inappropriate since each reference is non-analogous. Lari et al. discloses "an apparatus and method that combine a levitation magnet that produces low frequency magnetic field traveling waves with a stabilization magnet that produces a high frequency magnetic field to retain a metal in liquid form with a smooth vertical boundary." (Lari et al., col. 3, ll. 33-38.) Morishita et al. provides a process for uniformly etching "a sample at a high speed or to form a uniform and thick film on the sample by providing magnetic field generating means for

electrically generating a magnetic field." (Morishita et al., Abstract) As such, each of these references are in no way related to the field of growing silicon single crystals.

The fee of $500.00 as applicable under the provisions of 37 C.F.R. § 41.20(b)(2) is enclosed, along with a check in the amount of $120.00 for a one-month extension. Please charge any additional fee or credit any overpayment in connection with this filing to our Deposit Account No. 02-3978.

Respectfully submitted,

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Date: October 7, 2005

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Enclosure - Appendices

VIII. CLAIMS APPENDIX

1. A process far producing a silicon single crystal comprising

pulling a silicon single crystal from a silicon melt which is contained in a crucible having a crucible wall and having a crucible diameter of at least 450 mm,

placing a heat shield above said crucible; and said silicon single crystal being pulled with a diameter of at least 200 mm; and

exposing the silicon melt to a magnetic field consisting of a traveling magnetic field which exerts a substantially vertically oriented force on the melt in a region Of the crucible wall and

applying the magnetic field with an intensity which is sufficient to attenuate low-frequency temperature fluctuations in the melt.

2. The process as claimed in claim 1,

wherein the silicon single crystal is pulled with an oxygen concentration of at least $5 * 10^{17}$ atoms per cm^3.

3-13. (Canceled)

14. A process for producing a silicon single crystal, comprising

pulling a silicon single crystal from a silicon melt which is contained in a crucible having a crucible wall and having a crucible diameter of at least 450 mm.

placing a heat shield above said crucible;, and said silicon single crystal being pulled with a diameter of at least 200 mm; and

exposing the silicon melt to a magnetic field consisting of a traveling magnetic field which exerts a substantially vertically oriented force on the melt in a region of the crucible wall;

applying the magnetic field with an intensity which is sufficient to attenuate low-frequency temperature fluctuations in the melt; and

generating the magnetic field with three coils and connecting said three coils to a 3-phase power supply, with a phase angle in an order 0°-60°-120° or 0°-120°-240°.

15-16. (Canceled)

17. A process for producing a silicon single crystal, comprising

pulling a silicon single crystal from a silicon melt which is contained in a crucible having a crucible wall and having a crucible diameter of at least 450 mm,

placing a heat shield above said crucible; and said silicon single crystal being pulled with a diameter of at least 200 mm; and

exposing the silicon melt to a magnetic field consisting of a traveling magnetic field which exerts a substantially vertically upwardly oriented force on the melt in a region of the crucible wall, and

applying the magnetic field with an intensity which is sufficient to attenuate low-frequency temperature fluctuations in the melt.

18. A process for producing a silicon single crystal, comprising

pulling a silicon single crystal from a silicon melt which is contained in a crucible having a crucible wall and having a crucible diameter of at least 450 mm,

placing a heat shield above said crucible; and said silicon single crystal being pulled with a diameter of at least 200 mm; and

exposing the silicon melt to a magnetic field consisting of a traveling magnetic field which exerts a substantially vertically downwardly oriented force on the melt in a region of the crucible wall, and

applying the magnetic field with an intensity which is sufficient to attenuate low-frequency temperature fluctuations in the melt.

IX. EVIDENCE APPENDIX

None

X. RELATED PROCEEDINGS APPENDIX

None